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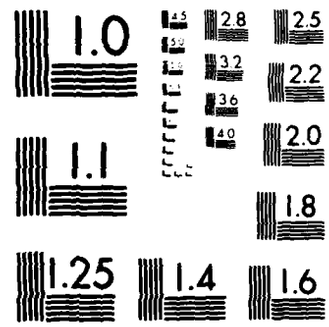

Research Progress and Forecast Report

Grant AFOSR 84-0089

October 1, 1984

"Research in Adaptive and Decentralized Control"

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In the first six and one-half months of research supported by this grant, we have begun to make significant progress in a number of aspects of the proposed research areas. First, we have continued to work on problems of adaptive stochastic control of queues with complete observations. This work has resulted in the publication during this research period of the papers [1], [2] (this research was previously supported by Grant AFOSR 79-0025). In [1], the priority assignment (or dynamic scheduling problem) in a queueing system with unknown arrival and service rate is considered. The long term average cost criterion with linear cost rates is solved, and the optimality of our proposed adaptive control algorithm is shown. A distance-measures approach to the problems of identification and approximation of queueing systems is presented in [2]; this approach combines ideas from statistical robustness, information-type measures, and parameter-continuity of stochastic processes.

The stochastic adaptive control problems solved to date have all, with the exception of those for linear systems, involved the assumption of complete (noiseless) state observations. As we proposed, we have begun a major new direction of research involving adaptive estimation and control problems for

stochastic systems with incomplete (or noisy) observations of the state. We have already been successful in obtaining some important new results; these are reported in [3]. In [3], we consider discounted Markov decision processes with incomplete state information and depending on unknown parameters. The process is first transformed into a completely observed Markov decision process and then (i) we use conditional least squares estimation to obtain a strongly consistent parameter estimation scheme, and this is combined with a nonstationary value-iteration procedure to obtain (ii) approximations converging uniformly to the optimal reward function, and (iii) asymptotically optimal adaptive policies. This paper provides important general results, but the specific structure of the parameter estimation scheme must be studied in more detail. For this reason, we have begun an in-depth investigation into problems in which the state is a (discrete or continuous time) finite state Markov process. Such problems are discussed in our proposal, in which we proposed to study convergence of parameter estimates, adaptive estimation, and adaptive control. This work is in progress, and we have begun to obtain preliminary convergence results. This problem is much more difficult than the linear problems considered to date, but our preliminary results are encouraging.

We have completed work in other areas which were initially supported under Grant AFOSR 79-0025. In [4], asymptotic approximations for some nonlinear filtering problems were derived, analyzed, and compared with other filters. Lie algebraic and analytical methods were utilized; of particular interest was the estimation problem for linear systems with infrequently jumping parameters. In [5] and [6], the structure of nonlinear control systems with symmetries was studied, and the results obtained were used to derive reduced-order algorithms for certain classes of optimal control problems.

Publications

1. O. Hernandez-Lerma and S. I. Marcus, "Optimal adaptive control of priority assignment in queueing systems," Systems and Control Letters, vol. 4, April 1984, pp. 65-72.

2. O. Hernandez-Lerma and S. I. Marcus, "Identification and approximation of queueing systems," IEEE Trans. on Automatic Control, vol. AC-29, May 1984, pp. 472-474.

3. O. Hernandez-Lerma and S. I. Marcus, "Adaptive control of Markov processes with incomplete state information and unknown parameters," submitted to Journal of Optimization Theory and Applications.

4. S. I. Marcus and E. K. Westwood, "On asymptotic approximations for some nonlinear filtering problems," Proc. IFAC Triennial Congress, Budapest, Hungary, July 2-6, 1984, vol. VII, pp. 36-41.

5. J. W. Grizzle and S. I. Marcus, "Optimal control of systems possessing symmetries," to appear in IEEE Trans. on Automatic Control, vol. AC-29, December 1984.

6. J. W. Grizzle and S. I. Marcus, "The structure of nonlinear control systems possessing symmetries," to appear in IEEE Trans. on Automatic Control, vol. AC-30, March 1985.

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